

General

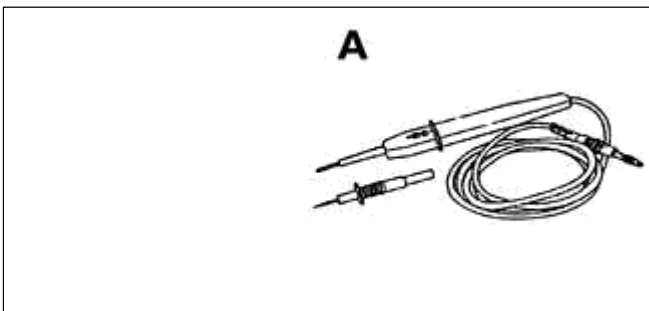
This repair group covers component replacement information for the ignition system.

When diagnosing engine management problems, including on-board diagnostics (OBD II) fault code analysis, also refer to these repair groups:

- ◆ ⇒ [100 Engine-General](#)
- ◆ ⇒ [130 Fuel Injection](#)
- ◆ Electrical Wiring Diagrams at the rear of this manual
- ◆ ⇒ [OBD On Board Diagnostics](#) at the rear of this manual

Special tools

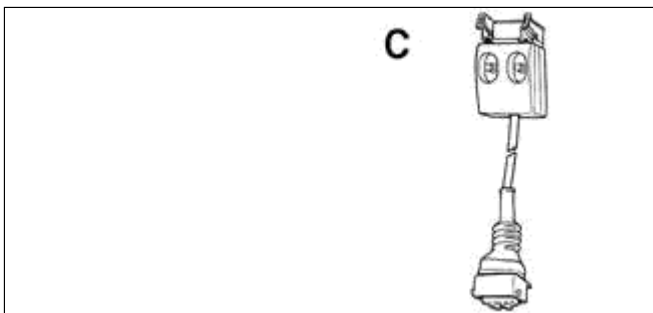
Owing to the coil-per-cylinder configuration, system diagnosis and testing requires special test equipment.



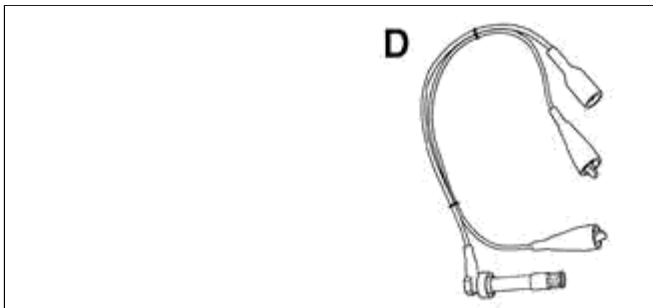
- ◀ LED test light Baum 1115 (Source: Baum Tools Unlimited)



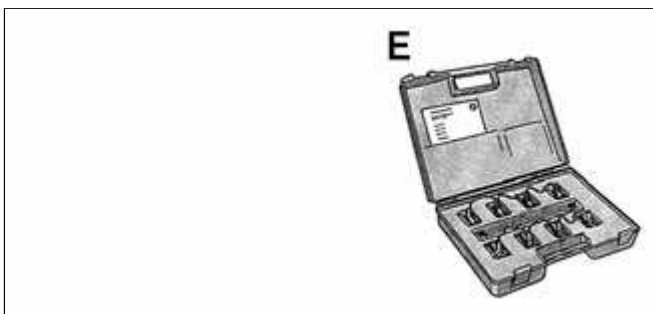
- ◀ Automotive digital multimeter Fluke 87



- Primary voltage test harness BMW 12 7 020



- Secondary voltage test harness BMW 12 7 030



- Ignition coil test adapters BMW 12 7 040

Engine management

BMW E46 engines use an advanced engine management system known as Digital Motor Electronics (DME). DME incorporates on-board diagnostics, fuel injection, ignition and other engine control functions. DME variants are listed in ⇒ [Table a](#).

Second generation On-Board Diagnostics (OBD II) is incorporated into the engine management systems used on the cars covered by this manual. Using a BMW-specific electronic scan tool, it is possible to access Diagnostic Trouble Codes (DTCs) that pinpoint ignition and other engine management problems.

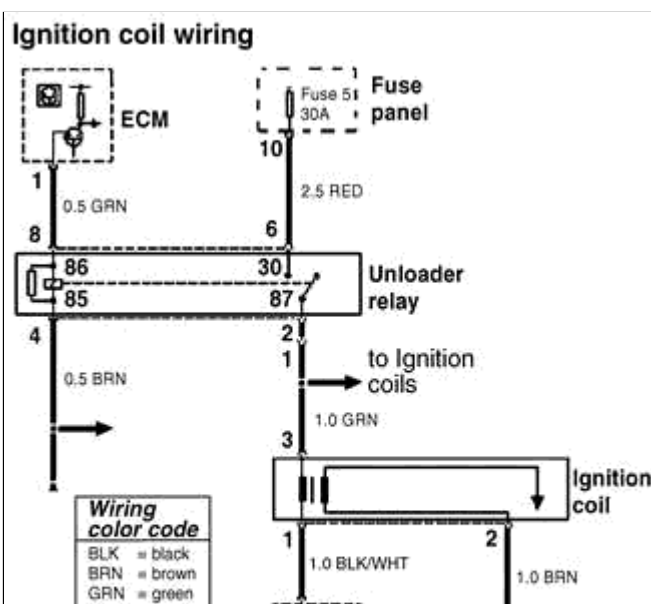
Additional information about DTCs and engine management system electronic system diagnosis is provided in ⇒ [OBD On Board Diagnostics](#) at the rear of this manual.

Table a. Engine management systems	
Year: Engine	DME system
1999 - 2000: M52 TU B25 M52 TU B28	Siemens MS 42.0
2001: M54 B25 M54 B30	Siemens MS 43.0

Ignition system



- ✦ All engines use a distributorless ignition system with individual ignition coils for each cylinder. There is no distributor cap or ignition rotor.

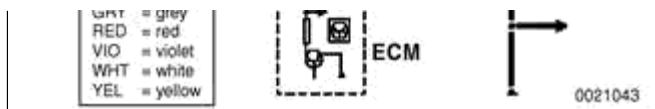


- ✦ Each coil can be controlled by the Engine Control Module (ECM) on a cylinder-by-cylinder basis.

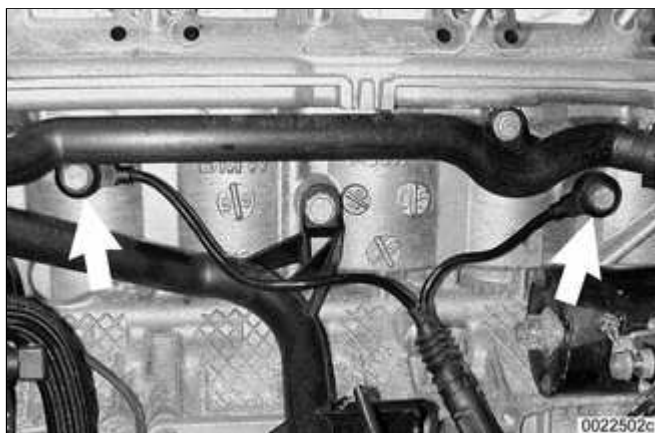
Note:

Schematic diagram of ignition coil circuit is for MS 42.0 engine management system. On MS 43.0 system, ignition coil terminal 3 receives power from Fuse 1 (30 amp). See Electrical Wiring Diagrams for specific wiring information.

WARNING!



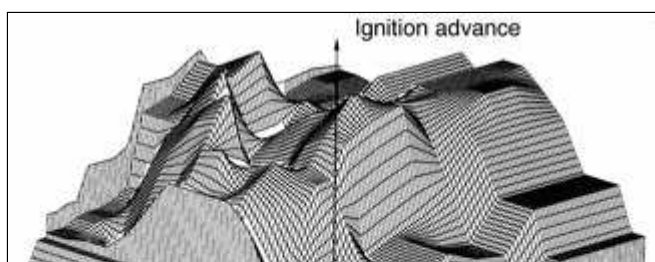
- ♦ **Do not touch or disconnect any cables from the coils while the engine is running or being cranked by the starter.**
- ♦ **The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.**
- ♦ **Connect and disconnect the DME system wiring and test equipment leads only when the ignition is OFF.**
- ♦ **Before operating the starter without starting the engine (for example when making a compression test) always disable the ignition.**



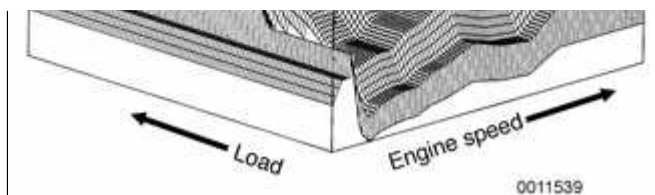
- ✦ Knock sensors (**arrows**) monitor the combustion chamber for engine-damaging knock. Two sensors monitor three cylinders each. If engine knock is detected, the ignition point is retarded by the ECM.

Note:

When knock is detected, ignition timing will be retarded at the selective cylinder(s) by 3° increments. If knock is no longer detected, the timing will be advanced in 1° increments.



- ✦ Ignition timing is electronically mapped and not adjustable. The ECM uses engine load, engine speed, coolant temperature, knock detection and intake air temperature as the basic inputs for timing control. A three



dimensional map similar to the one shown is digitally stored in the ECM.

The initial ignition point is determined by the crankshaft speed sensor during cranking. Once the engine is running, timing is continually adjusted based on operating conditions.

Basic troubleshooting principles

Poor driveability may have a variety of causes. The fault may lie with the ignition system, the fuel system, parts of the emission control system, or a combination of the three. Because of these interrelated functions and their effects on each other, it is often difficult to know where to begin looking for problems.

For this reason, effective troubleshooting should always begin with an interrogation of the On-Board Diagnostics (OBD II) system. The OBD II system detects engine management malfunctions. When faults are detected, the OBD II system stores a Diagnostic Trouble Code (DTC) in the Engine Control Module (ECM) along with other pertinent fault information. In addition, the Malfunction Indicator Light (MIL) will come on if an emissions related fault is detected. Additional OBD II information, including a DTC lookup table can be found in the back of this manual under ⇒ [OBD On Board Diagnostics](#).

Note:

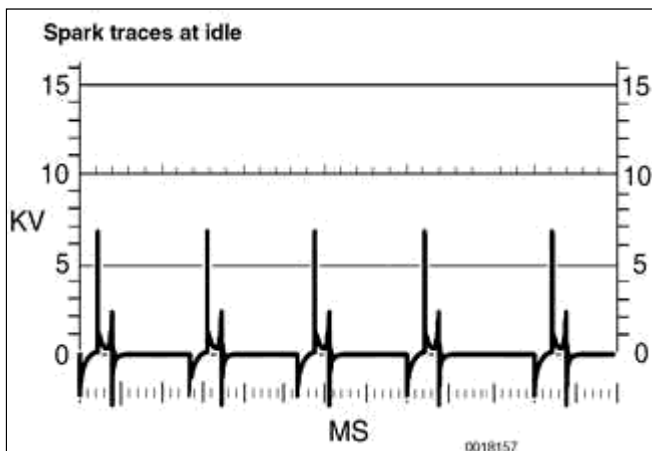
On model year 1999 and 2000 cars, the MIL is labeled Check Engine. On model year 2001 cars, the MIL is labeled Service Engine Soon.

An engine that starts and runs indicates that the ignition system is

fundamentally working-delivering voltage to the spark plugs. A hard-starting or poor-running engine, however, may indicate a problem with how well the spark is delivered. Faulty or worn ignition components, such as old spark plugs, or an individual coil problem may be the cause.

WARNING!

Inefficient combustion (rich air/fuel mixture) can cause elevated hydrocarbon exhaust emissions and catalytic converter damage. For this reason, if a severe misfire is detected, the fuel injector will be turned off to the specific cylinder and the MIL illuminated.

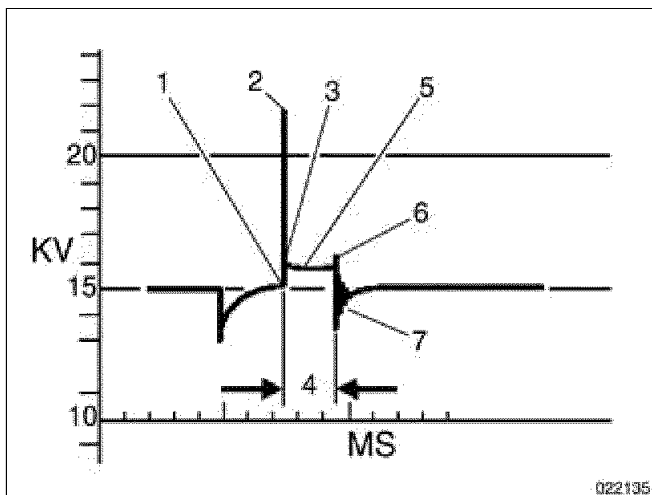


- One way to diagnose a faulty coil on a car that is running is to use an oscilloscope to analyze spark quality. The illustrations show normal scope trace of spark at idle.

⇒ [Table b](#) lists common ignition coil voltage faults and related causes.

Note:

Note the length of sparking period and the up-down voltage attenuations. A short sparking period and/or an irregular/low voltage attenuation usually indicates a faulty coil.



- A normal oscilloscope pattern for a six cylinder engine.

- 1 - Start of ignition voltage peak
- 2 - Level of ignition voltage
- 3 - Level of combustion voltage
- 4 - Period of combustion
- 5 - Combustion curve characteristics
- 6 - Start of decay process

7 - Termination oscillations

Note:

See ⇒ [Ignition coil assembly, testing and replacing](#) as described later.

Table b. Ignition trace diagnostics		
Parameter	Ignition voltage low	Ignition voltage high
Spark plug electrode gap	too small	too big
Spark plug electrode condition	-	worn/burnt
Spark plug electrode temperature	too high	too low
Engine compression	too low	too high
Spark plug wire(s)	-	faulty
Fuel air mixture	-	too lean

Misfire detection

Engine misfire, the result of inefficient combustion in one or more cylinders, may be caused by a variety of malfunctions in various subsystems.

The OBD II system incorporated into the MS 42.0 and MS 43.0 engine management systems is designed to detect and warn of misfire faults during engine operation. Misfire fault codes are listed in ⇒ [Table c. Misfire fault codes](#). For a detailed list of fault codes see ⇒ [OBD On Board Diagnostics](#).

Once engine misfire has been detected and the fault codes downloaded from the ECM, it is necessary to follow a diagnostic path to correct the problem. The ignition subset of the diagnostic path is shown in ⇒ [Table d. Ignition system problems](#)

Table c. Misfire fault codes

P code	BMW fault code	Fault code	Possible cause(s)
P0301	238	Misfire cylinder 1	Ignition fault: Defective or incorrect spark plug(s) or connector(s); defective ignition coil(s) Mechanical fault: Crankshaft pulse wheel loose or damaged; damaged piston(s), valve(s) or camshaft(s); oil pressure low Catalyst fault: Excessive exhaust backpressure due to restricted catalyst Fuel supply fault: Contaminated fuel; fuel delivery fault (blocked filter, low fuel in tank, defective fuel pump); running loss system fault; leaking or blocked fuel injector(s); fuel pressure regulator fault; evaporative system fault ECM/sensor input fault: Implausible sensor signal; oxygen sensor(s) faulty; ECM faulty
P0302	239	Misfire cylinder 2	
P0303	240	Misfire cylinder 3	
P0304	241	Misfire cylinder 4	
P0305	242	Misfire cylinder 5	
P0306	243	Misfire cylinder 6	
P1396	244	Crankshaft sensor adaptation at limit	Misfire detection fault: Varying pulse wheel tolerances or loose pulse wheel

Table d. Ignition system problems

Component	Condition	Test	Repair
Spark plug	Incorrect spark plug Electrode gap too small Electrode(s) missing Oil or fuel fouled spark plug Ceramic insulation cracked	Inspect spark plugs.	Verify correct spark plugs. Replace plugs if defective. Check crankcase ventilation and oil level.

Component	Condition	Test	Repair
Secondary circuit	Wet coil Corroded coil connections	Secondary circuit	Check for water leak. Check resistance values (see ⇒ Table e).
Ignition coil	Primary or secondary circuit on or shorted Housing cracked, damaged	Primary and secondary circuits (see ⇒ Table e)	Replace coil as necessary.
Ignition coil harness connector	Power supply, primary control circuit or ground (shunt signal) circuits impaired	Primary ignition and terminal 4A feedback preset measurements	Look for open, loose connector, corrosion, crossed or damaged connector pins. Inspect ignition unloader relay. Replace coils as necessary.

Warnings and cautions

The engine management system contains sensitive electronic components. To protect the system and for general safety, the following warnings and cautions should be observed during ignition system troubleshooting, maintenance or repair work.

WARNING!

- ♦ ***Do not touch or disconnect any cables from the coils while the engine is running or being cranked by the starter.***
- ♦ ***The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.***

- ♦ **Connect and disconnect the DME system wiring and test equipment leads only when the ignition is OFF.**
- ♦ **Before operating the starter without starting the engine (for example when making a compression test) always disable the ignition.**

CAUTION!

- ♦ **Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.**
- ♦ **Do not attempt to disable the ignition by removing the coils from the spark plugs.**
- ♦ **Connect or disconnect ignition system wires, multiple wire connectors, and ignition test equipment leads only while the ignition is off. Switch multimeter functions or measurement ranges only with the test probes disconnected.**
- ♦ **Do not disconnect the battery while the engine is running.**
- ♦ **A high impedance digital multimeter should be used for all voltage and resistance tests. An LED test light should be used in place of an incandescent-type test lamp.**
- ♦ **In general, make test connections**

only as specified by BMW, as described in this manual, or as described by the instrument manufacturer.

Ignition System Service

Ignition firing order



- Each ignition coil is mounted above the corresponding spark plug. Cylinder 1 is at the front of the engine.

Ignition firing order	
M52 TU/M54 engine	1 - 5 - 3 - 6 - 2 - 4

Disabling ignition system

The ignition system operates in a lethal voltage range and should therefore be disabled any time engine service or repair work is being done that requires the ignition to be switched on.

- The engine management system can be disabled by removing the DME main relay (**arrow**). The relay is located in the electronics box (E-box) in the left rear of the engine compartment.



CAUTION!

Relay locations may vary. Use care when identifying relays. The main relay has a large (4 mm 2) red wire at terminal 30 and a large (4 mm 2) red/white wire at terminal 87. See ⇒ [610 Electrical Component Locations](#).

Checking for spark

CAUTION!

If a spark test is done incorrectly, damage to the Engine Control Module

(ECM) or the ignition coils may result.

Note:

Spark plug replacement is covered in ⇒ [020 Maintenance](#).

Checking for spark is difficult on engines with distributorless ignition systems.

Try removing the spark plugs and inspecting for differences between them. A poor-firing plug may be wet with fuel and/or black and sooty, but not always. If a coil is not operating, the engine management system will electrically disable the fuel injector to that cylinder. The key is to look for differences between cylinders.

Ignition coil assembly, testing and replacing

CAUTION!

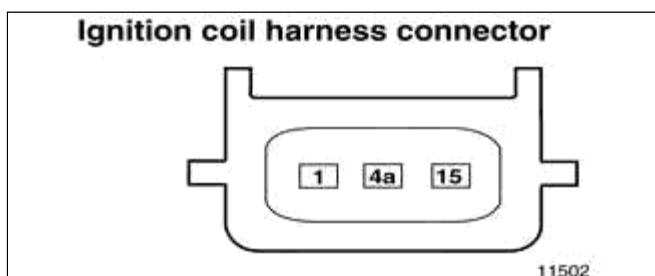
Use a digital multimeter for the following tests.



- ◀ Remove interior ventilation microfilter.



- ◀ Remove housing for microfilter for interior ventilation.
 - ◆ Open wiring harness loom (A) and remove wires.

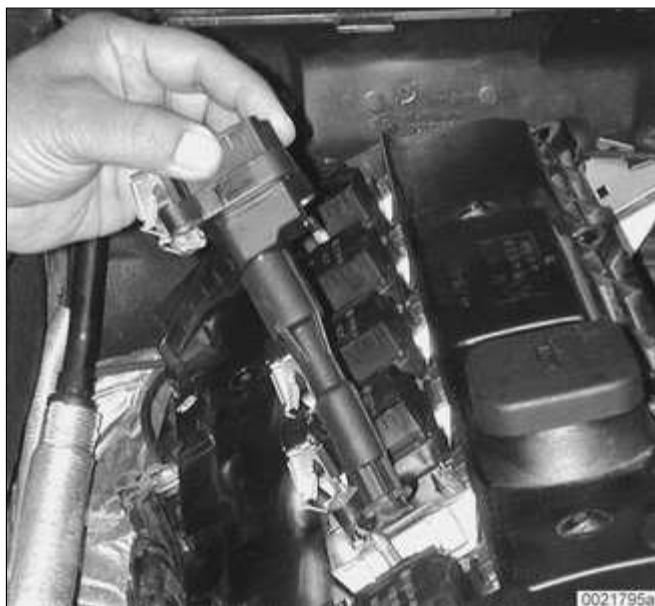


- ◆ Unfasten screws (B) and remove lower microfilter housing.
- Remove plastic engine cover from top of valve cover by prying off bolt covers and removing cover mounting bolts.
- ✦ Disconnect harness connector from coil. Connect multimeter between terminal **15 (+)** in connector and ground.
- Turn ignition on and check for battery voltage.
- ◆ If battery voltage is not present, check wire between terminal **15** and ignition switch. See Electrical Wiring Diagrams.

CAUTION!

The wiring to terminal 15 (+) of the coil (via the ignition switch) is not fuse protected. Use care when testing this circuit.

- Turn ignition off.



- ✦ Remove coil and inspect coil housing for hairline cracks or leaking casting material. A leaky ignition coil may indicate a faulty Engine Control Module (ECM). Check ECM before installing a new coil.

CAUTION!

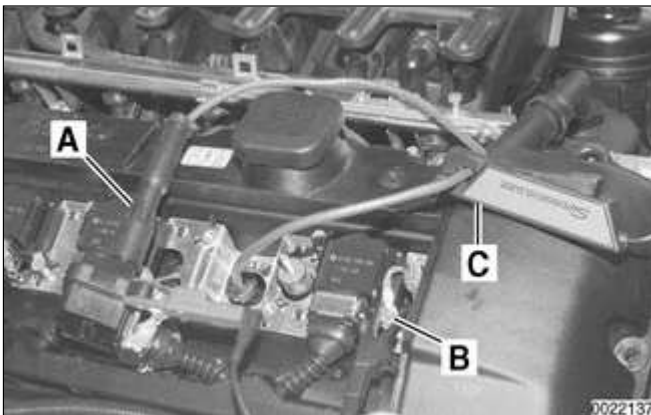
Note location of coil ground straps before coil removal; reinstall in the same location.

- Use a multimeter to test:

- ◆ Coil primary resistance at coil terminals
- ◆ Spark plug connector resistance
- ◆ Compare results to specification in ⇒ [Table e.](#)

Table e. Ignition coil resistance		
Component	Terminals	Resistance
Coil primary	1 (-) and 15 (+)	approx. 0.8 Ω
Coil secondary		N.A.
Spark plug connector		
Bosch		1 k Ω 20%
Beru		1.8 k Ω 20%

- Replace ignition coil or spark plug connector if resistance readings do not meet specifications.

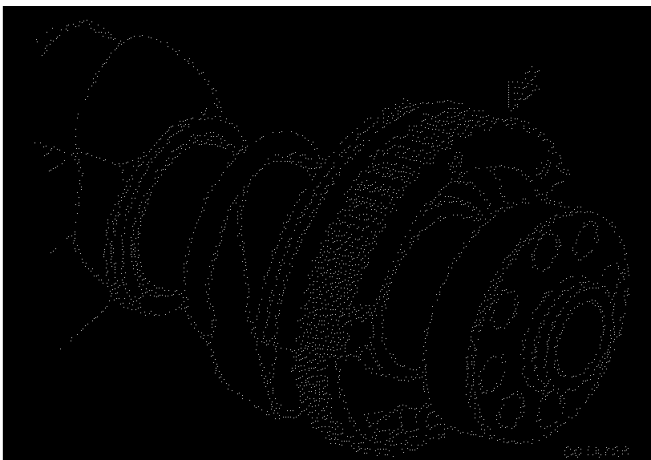


- Remove ignition coil to be tested.
 - ◆ Install BMW special tool 12 7 030 (A) on coil to be tested.
 - ◆ Connect ground jumper between coil mounting point and engine ground point (B).
 - ◆ Clip scope high pick-up lead (C) around ignition lead.
 - ◆ Start engine.

- ◆ Compare scope pattern with diagrams in ⇒ [Basic troubleshooting principles](#).

Note:

When replacing ignition coils, ensure that the replacements are from the same manufacturer with the same part/code numbers. If individual coils with the correct specifications are not available, all coils should be replaced.

Crankshaft speed sensor, replacing

- ◀ The crankshaft speed sensor is mounted in the left rear side of the cylinder block below the starter. The sensor reads a toothed pulse wheel (**arrow**) mounted to the end of the crankshaft.

If the Engine Control Module (ECM) does not receive a signal from the crankshaft speed sensor during cranking, the engine will not start.

If the OBD II system misfire detection protocol detects a catalyst damaging fault due to a malfunction in crankshaft speed sensor components, the Check Engine light (Malfunction Indicator Light or MIL) will be illuminated.

Note:

If the crankshaft speed sensor pulse wheel is damaged, the engine will have to be disassembled down to the crankshaft to replace the wheel.

- Make certain ignition has been turned off.

- Raise car and support in a safe manner.

WARNING!

Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove under-engine splash guards.

**⚠ Working just underneath starter:**

- ◆ Cut off wire tie securing crankshaft speed sensor harness connector (**arrow**) to sensor.
- ◆ Disconnect harness connector.

**⚠ Remove sensor mounting screw (**arrow**) and remove sensor from cylinder block.**

- Installation is reverse of removal, noting the following:
 - ◆ Use a new O-ring when installing sensor.
 - ◆ Be sure wiring is rerouted in same orientation.
 - ◆ Secure sensor using new wire ties.
 - ◆ Use scan tool to read out and clear

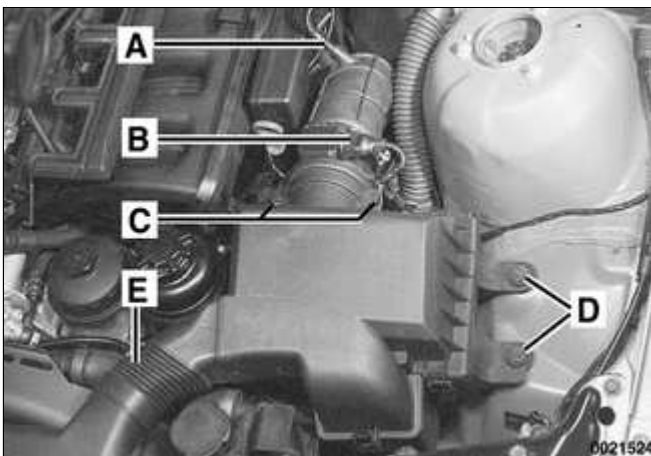
ECM fault memory.

Camshaft position sensors

The camshaft position sensors are used by the engine management system for VANOS control, sequential fuel injection and knock control.

Intake camshaft position sensor, replacing

- Make certain ignition has been turned off.
- Remove housing for the microfilter for interior ventilation as shown earlier.
- Remove plastic cover from above fuel injectors by prying off bolt covers and removing cover mounting bolts.



- ◀ Remove complete air filter housing:
 - ◆ Disconnect electrical harness connector on mass air flow sensor (B).
 - ◆ Detach vacuum line at intake boot (A).
 - ◆ Remove filter housing mounting screws (D).
 - ◆ Loosen hose clamp at intake boot and detach air duct connections (C).

- ◆ Disconnect cold air duct tube (E).
- Disconnect harness connector from VANOS solenoid and unscrew solenoid from VANOS control unit. Be prepared with shop rags to catch oil released from VANOS unit.



◀ Remove camshaft sensor (**arrow**) from left front of cylinder head, next to top of oil filter housing.

- Disconnect camshaft sensor harness from under intake manifold. Prior to removal, attach a stiff piece of wire to the harness connector end to preserve proper routing of harness for reinstallation.
- Installation is reverse of removal.
- ◆ Use new O-rings when installing sensor and solenoid.
- ◆ Be sure wiring is rerouted in same orientation.
- ◆ Use scan tool to read out and clear ECM fault memory.

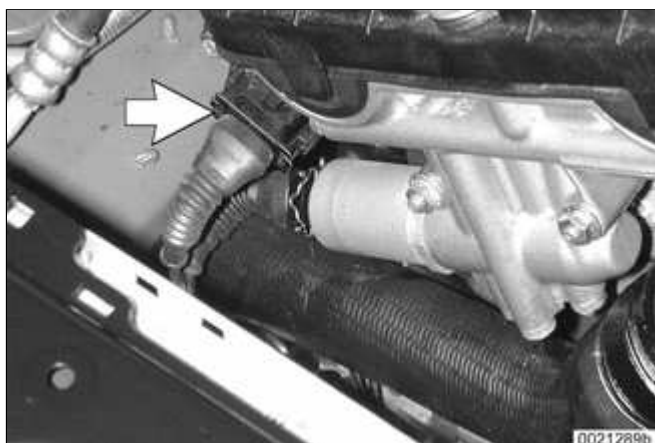
Tightening torques

Intake camshaft sensor to cylinder head	5 Nm (3.5 ft-lb)
VANOS solenoid to VANOS control unit	30 Nm (22 ft-lb)

Exhaust camshaft position

sensor, replacing

- Make certain ignition has been turned off.



⚠ Working at front of engine on exhaust (**right**) side, detach exhaust camshaft position sensor electrical harness connector (**arrow**).

- Remove camshaft sensor from right front of cylinder head.
- Installation is reverse of removal.
- ◆ Use a new O-ring when installing sensor.
- ◆ Be sure wiring is rerouted in same orientation.
- ◆ Use scan tool to read out and clear ECM fault memory.

Tightening torque

Exhaust camshaft sensor to cylinder head	5 Nm (3.5 ft-lb)
--	------------------

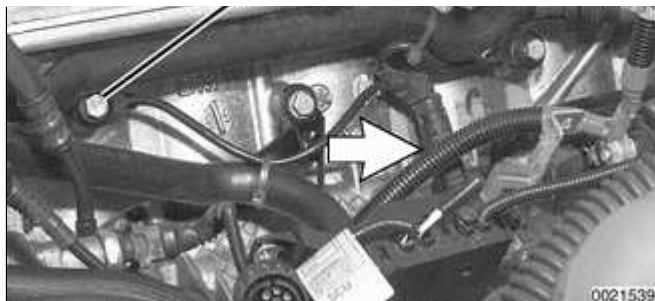
Knock sensors, replacing

The knock sensors are bolted to the left side of the cylinder block under the intake manifold.

- Remove intake manifold as described in ⇒ [113 Cylinder Head Removal and Installation](#).



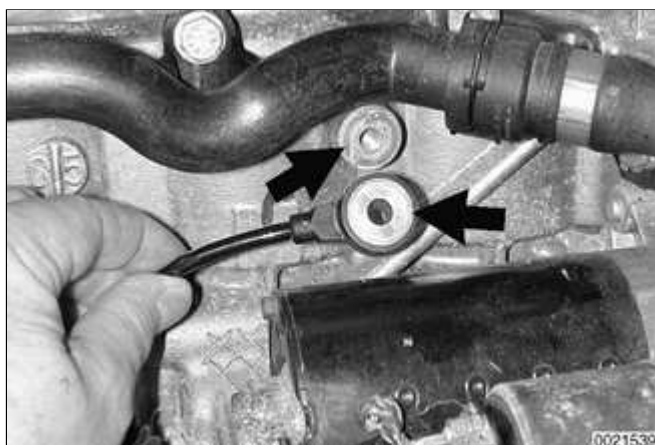
⚠ Disconnect knock sensor electrical harness connector (**arrow**) on left side of engine cylinder block.



- ◆ Remove knock sensor mounting bolts (**A**) on side of cylinder block. Remove sensors.

CAUTION!

Note the installed angle of the knock sensor on the block before removing it. Reinstall the sensor in the same position. Be sure to use a torque wrench when tightening the sensor mounting bolt.



- ◀ Clean knock sensor contact surface on engine block and sensor (**arrows**) before installing knock sensor.

Tightening torque	
Knock sensor to cylinder block	20 Nm (15 ft. lbs.)

- Use scan tool to read out and clear ECM fault memory.